

NOMINATION REPORT
for the
BENDEMEER BRIDGE
as an
HISTORIC ENGINEERING MARKER
celebrating its centenary in 2005



The 1905 composite steel and timber Dare truss over the MacDonald River.

Prepared by Don Fraser for
Engineering Heritage Australia (Newcastle)
Engineers Australia
September 2004

CONTENTS

Plaque Nomination form	1
Location map	2
Introduction	3
Plaque Nomination Assessment form	4
Statement of Significance	6
Proposed Plaque Citation	8
Biosketches	
Henry Harvey Dare – designer	9
W F Oakes – builder	10
Images – 1905 opening and the bridge today	11
Appendices	
Great North Road	12
Historic Bendemeer	15
The 1st Bendemeer Bridge	18
Evolution of the Timber Truss Bridge, NSW	20
The 2nd Bendemeer Bridge	23

Plaque Nomination Form

The Administrator
Engineering Heritage Australia
Engineers Australia
Engineering House
11 National Circuit
BARTON ACT 2600

Name of Work: **BENDEMEER BRIDGE**

The above-mentioned work is nominated to be awarded a

Historic Engineering Marker

Location, including address and map reference:

MacDonald River, Bendemeer

Owner (name and address):

Tamworth Regional Council

The owner has been advised of this nomination, and agreement identified:

Ruth Mathews, Community Officer has confirmed that "Council is very involved with the centenary of the bridge" – consent notification attached.

Access to site: Public bridge

Nominating Body:

Engineering Heritage Committee, Sydney.

Chairman: *Glenn Rigden*

Engineering Heritage Committee Sydney

Date: *October 2004*

From: Carey, James <j.carey@tamworth.nsw.gov.au>
To: <fraser.don@bigpond.com>
Cc: <jallen@tamdevcorp.com.au>, "Inglis, Glenn"
<g.inglis@tamworth.nsw.gov.au>, "Bayley, Ann-Maree"
<a.bayley@tamworth.nsw.gov.au>
Date: Wednesday, 22 September 2004 9:44 PM
Subject: Bendemeer Bridge: Proposed Plaque Citation

Dear Mr Fraser,

This email pertains to prior communications with and between Tamworth Regional Council and various parties in regard to the placing of a plaque on the historic Dare truss bridge at Bendemeer.

This morning, Mr John Allen of Tamworth Development Corporation spoke to me in the absence of Council's Mr Glenn Inglis (Acting Director Business and Marketing Division) with regard to a request from you for written confirmation of the aforementioned.

Mr Inglis is not in Council's offices today.

However, I am familiar with this project, and have personally spoken about it by telephone today to Mr Inglis (since Mr Allen's contact).

I confirm, for and on behalf of Mr Inglis, that consent has been provided.



The reason for the delay was that, as a matter of protocol, this Division of Council requested endorsement of the plaque proposal from Council's Technical Services Division. This endorsement was forthcoming yesterday.

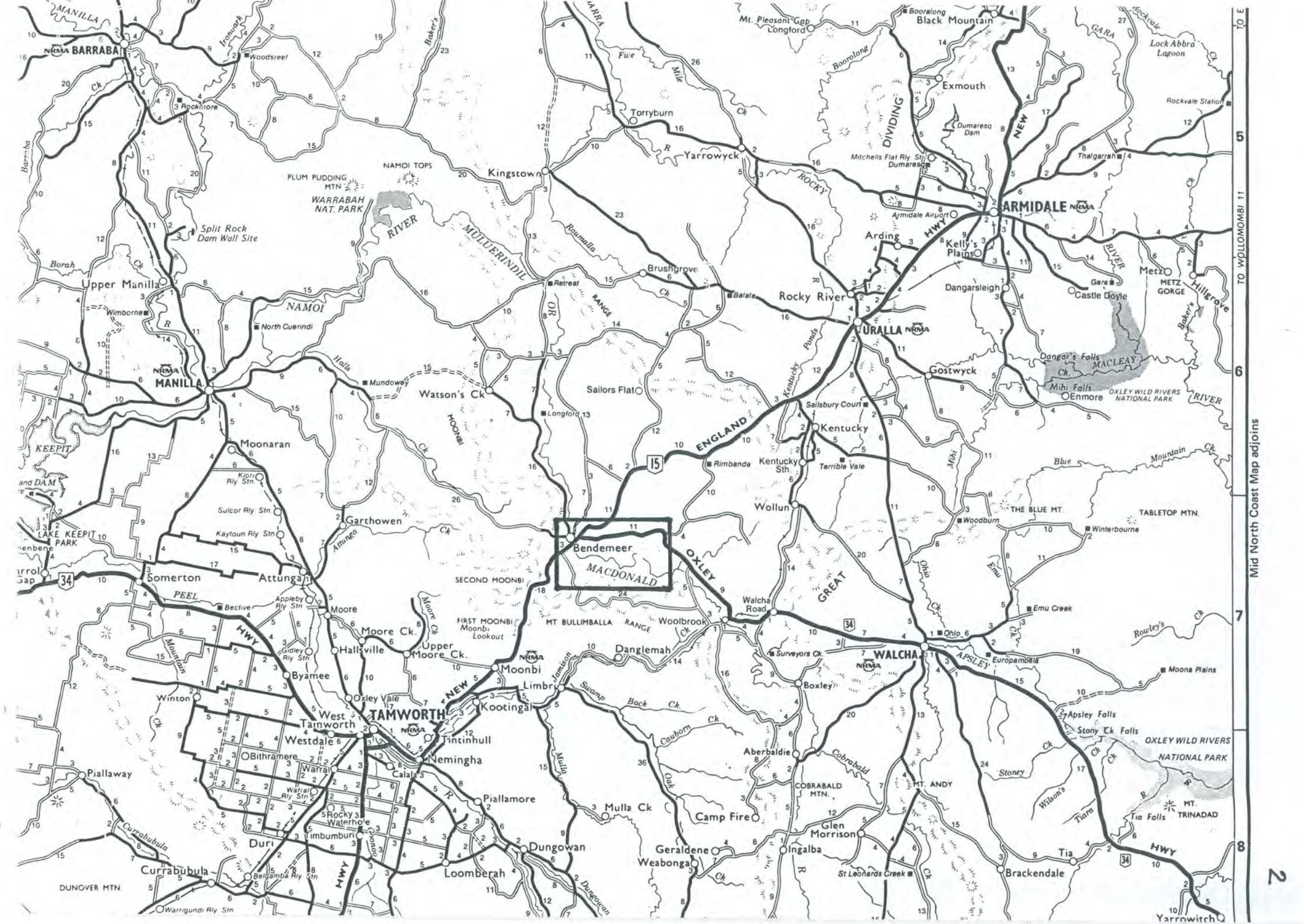
Mr Inglis will be in his office on Monday next should you need to directly discuss the matter further with him.

The formal letter requested will be sent next week. In the interim, please accept this email as confirmation in writing.



Jim Carey
Business Support Officer
Business and Marketing Division
Tamworth Regional Council

This is a Confidential Communication from Tamworth Regional Council. If you are not the intended recipient please contact the sender or telephone Council on +61 2 6755 4555.



Introduction



Bendemeer Dare truss over Macdonald River and its designer Harvey Dare (in senior years)

In Bendemeer April 2005 the community plans to celebrate the centenary of its MacDonald River Bridge. It is listed in the Australian Heritage Database with the following statement by Prof. Colin O'Connor in 1985.

Completed in 1905, it is one of the first examples of the Dare truss designed by H H Dare in 1903 and placed in service from about 1904 until at least 1912. This type was a composite Howe truss bridge with timber upper chords and compression diagonals, a metal lower chord and metal tension rods for the verticals. It was designed for spans of 22.4m and 31.7m. The Bendemeer Bridge is of considerable age for a timber bridge; the span is also considerable for a timber truss bridge. The bridge is thus of considerable technological significance.

The bridge carries a 5.2m roadway and has spans of 9m, 10.6m, 10.6m, 10.5m, 31.6m, 9.3m and 9.2m. The six approach spans are timber girders. The main span is a half through composite truss of the Dare type. The main piers are concrete.

The bridge is believed to be still in service, it appears to be in good condition and is in its original form.

Subsequent historical research for the Roads and Traffic Authority, NSW has revealed Dare truss bridges up to 1936 and the bridge at Bendemeer was the first Dare truss erected. They are the next most common form of timber truss road bridge after the Allan trusses. The Dare truss at Bendemeer is out of service due to the 1985 bypass of the New England Highway but is used as a footbridge in times of high water over the nearby road causeway. Heritage funds are being sought for its continuing survival.

The Dare design was the last in a five-stage evolution of timber truss bridges in NSW starting in the 1860s. They were OLD PWD, McDonald, Allan, de Burgh and Dare trusses. Examples of the inner three types have been plaqued and the Bendemeer Bridge will be the first Dare truss plaqued.

Harvey Dare was one of the celebrated bridge designers of the PWD around 1900 and ended his illustrious engineering career as the first Commissioner of the Water Conservation and Irrigation Commission, NSW. The contractor was the prominent bridge builder W F Oakes.

The 2005 celebrations will consist of a re-enactment of the official 1905 opening as well as having a "Back to Bendy" re-union weekend on 1st, 2nd and 3rd April when the whole township will revert to 100 years ago.

Engineering Heritage Australia, through its committees at Newcastle and Sydney, would like to honour the celebrations for this historic, heritage-listed bridge with a plaquing ceremony.

Plaquing Nomination Assessment Form

1. BASIC DATA

Item name: Bendemeer Bridge
Other/Former Names:
Location: MacDonald River, Bendemeer
Address: Bendemeer, NSW
Suburb/Nearest Town: Bendemeer, NSW
State: New South Wales
Local Government Area: Tamworth Regional Council (was Parry)
Owner: Tamworth Regional Council (was Parry)
Current Use: Footbridge
Former Use: Traffic bridge for New England Highway
Designer: Harvey Dare
Maker/Builder: W F Oakes
Year Started: 1904 **Year Completed:** 1905

Physical Description: The principal structure of the bridge is a composite steel and timber truss known as a Dare Truss which spans 31.7m (104ft) over the MacDonald River. The truss rests on concrete piers. There are six timber beams spans, two on the south side and four on the north side, average span 9.3 m (30.5ft).

Physical Condition: Good – still safe for pedestrians

Modifications and Dates:

Historical Notes: The Bendemeer region was discovered by explorers John Oxley (1818), Allan Cunningham (1827) and Sir Thomas Mitchell (1831). Atop the Mooni Range north of Tamworth, there was a convenient resting place for travelers and stock with a causeway across the Muluerindie (MacDoanald) River, which became the site of the village of Bendemeer named after the nearby "Bendemeer Station".

The river proved to be a treacherous crossing for what had become the Great North Road to the prosperous New England Tablelands and by 1865 a 3-span laminated timber arches bridge had been built. However, laminated

construction was unsuccessful mainly due to water penetrating between the laminates causing rot. The bridge was closed in 1895.

By that time timber truss bridges had reached their zenith with the development of a new composite steel and timber truss by Public Works engineer Harvey Dare in 1903. The first of his new design was built at Bendemeer and opened on 29 September 1905. It served the New England Highway until the village was bypassed by a road deviation to the east in 1985.

Heritage Listings:

Name:	Australian Heritage Database
Title:	Macdonald River Road Bridge, New England Hwy, Bendemeer, NSW.
Number:	7083 (1/02/173/0007)
Date:	18 April 1989

2. ASSESSMENT OF SIGNIFICANCE

Historic Phase: The Bendemeer Bridge has historical significance due to its place in the evolving pattern of bridge design in Australia, particularly in NSW where Percy Allan, E M de Burgh and Harvey Dare were putting Australian bridges on the international scene around 1900. The successful consolidation of the settlement of the New England Region was dependent on improved land transport, road and rail, which in turn depended on bridging many major rivers. Both modes crossed the Macdonald River on significant bridges, an iron lattice rail bridge at Woolbrook and the Dare timber truss at Bendemeer. It was an important river crossing from 1905 to 1985 when it was bypassed

Historic Association: The Bendemeer bridge has historical association with eminent Public Works Department engineer Harvey Dare and prominent bridge builder W F Oakes.

Creative or Technical Achievement: Harvey Dare's composite steel and timber truss design was an improvement upon the pioneering work by E M de Burgh whose composite truss only had a short design and construction period, 1899-1905. Many more Dare composite trusses were built from 1905 to 1935. The success of the Dare composite truss can be measured by its 27 survivors, six of which are on the State Heritage Register

Research Potential: The bridge design work of Harvey Dare has been well researched already.

Aesthetics: The bridge sits prominently within a clear river valley. It is a handsome structure and still retains a degree of 'gateway' quality.

Social: The bridge has high significance to the local and district residents, typified by their initiative to celebrate the centenary of the bridge. Although the bridge was taken out of service as a road bridge in 1985 and replaced locally by a low-level, flood-prone causeway, it is still a valued asset for pedestrians.

Rarity: Not rare, there are 27 Dare truss road bridges in service.

Representativeness: Although 27 examples of Dare timber truss road bridges are in service, the Bendemeer truss is used as a footbridge so is completely and safely accessible.

Integrity/Intactness: The bridge is essentially as originally constructed and is still functional, albeit only for pedestrians.

References:

Author	Title
Don Fraser	"Evolution of the timber Truss Bridge in NSW"
Don Fraser	Biosketch of Harvey Dare
Malcolm Oakes	Biosketch of W F Oakes
Ruth Mathews	History notes on Bendemeer
Percy Allan	"Highway Bridge Construction" 6-part series in 1924

Statement of Significance: (summary of important items from the assessment)

The Bendemeer Bridge has significance under the four principal heritage criteria

- Historical and Association, Technical, Social and Aesthetics.

- 1(a) **Historically** because of its place in the evolving pattern for bridge design in NSW, particularly with timber truss road bridges and its long-service to the development of the northern New England Region of NSW.
- 1(b) By **Association** with eminent Public Works engineer Harvey Dare and prominent bridge builder W F Oakes.
2. **Technically** because Harvey Dare produced a composite steel and timber truss bridge that was superior to previous designs as evidenced by the large number of survivors in service.
3. **Socially** because of its continuing great benefit to Bendemeer albeit now as a footbridge.
4. **Aesthetically** because of its position in the river valley and in relation to the village of Bendemeer it still retain a 'gateway' quality.

Assessed Significance: **LOCAL**

Image with caption:



The 1905 Dare truss bridge over the MacDonald River, Bendemeer

Approved Plaque Citation:

**IEAust
Logo**

HISTORIC ENGINEERING MARKER

Bendemeer Bridge

Public Works engineer Harvey Dare designed this composite steel and timber truss bridge. It was constructed by prominent bridge builder W F Oakes and opened on 29 September 1905. The truss type, now known as a Dare truss, was the zenith of timber truss development being technically superior to previous types. The bridge was in service for the New England Highway for 80 years before being replaced in 1985.

**The Institution of Engineers Australia
Tamworth Regional Council
Community of Bendemeer 2005**

Henry Harvey DARE



Harvey Dare (1867-1949) was one of Australia's foremost engineers of the late colonial period and the early 20th century. He was born in Goulburn, NSW but attended Sydney Grammar School. He received his engineering education at Sydney University's School of Engineering under Prof. W H Warren, graduating with a BE and University Medal in 1888. In 1894 he gained a second University Medal for his Master of Engineering. He assisted in Prof. Warren's extensive programme of testing most of the timber species of NSW for their engineering properties which proved so useful in the design of timber infrastructure such as the timber truss bridges. At age 20 he was an Assistant at the Sydney Observatory but in February 1889 he joined the New South Wales Department of Public Works. He became a specialist in the design and construction of bridges, water-supply schemes and dams.

By 1901, he had been associated with many major bridges under the direction of Percy Allan and E M de Burgh. In 1905 he developed the composite timber and steel truss that now bears his name, 27 of which were in service as at 2004 with six on the State Heritage Register. He and JJC Bradfield were closely involved in the preliminaries for the Sydney Harbour Bridge. He pioneered the use of a distinctive type of bascule bridge which had counterweights moving down a curved track so as to maintain balance. By 1904 he was Assistant Engineer in charge of Design.

In 1910 he was transferred to rivers, water-supply and drainage as Principal Assistant Engineer to LAB Wade and was engaged in the preparations for the Murrumbidgee Irrigation Scheme including Burrenjack Dam, now a National Engineering Landmark.

In 1911 he was appointed Engineer for Water-supply, Sewerage and Drainage and assumed responsibility for planning three dams of the Upper Nepean Scheme (Cordeaux, Avon and Nepean). He concluded his career with Public Works Department as Chief Engineer for National Works and Drainage.

With the establishment of the Water Conservation and Irrigation Commission in 1913 he was appointed Chief Engineer and then Commissioner in 1916 during which time he oversaw the completion of Burrenjack Dam. In 1923 he represented NSW on the River Murray Commission.

He was prominent in professional bodies, receiving two Telford Premiums from the Inst. Civil Engrs., London and the Peter Nicol Russell Medal from the Inst. Engrs. Aust. He retired in May 1935 after 47 years in public service. He was one of Australia's outstanding civil engineers.

Walter Frank Oakes **a career in bridge building** *(Notes from Peter and Malcolm Oakes)*

W F Oakes, in partnership with his brother Percy, was a prominent and successful bridge builder in New South Wales during the first 25 years of the 20th century. They appeared to have followed on from their father's (William Frank) bridge building exploits in New Zealand in the 1880s. William Frank actually died on construction of the Smoky Cape Lighthouse, Kempsey, NSW. Walter Frank was a Whitworth Scholar, a prestigious UK award endowed by famed 19th Industrialist Sir Joseph Whitworth (Whitworth screw thread).

The Oakes brothers specialised in heavy timber constructions mainly in like structures of wharves and bridges. Family records show in excess of 60 projects 1905-1933 mostly in the North East quarter of NSW. The range of bridge sizes stretched from small timber beam structures for Local Government Councils, through a series of timber truss bridges plus a large steel truss bridge, all for the Department of Public Works. A chronology of their important bridge works includes,

Allan timber trusses

- 1897 Dyke Creek, Kempsey
- 1897 Tantawonglo Creek, Kameruka
- 1900 Styx River, Jeogla, Kempsey to
Armidale Road - **EXTANT**
- 1920 Murrumbidgee River, Narrandera

de Burgh composite timber trusses

- 1902 Black Creek, Rothbury - **EXTANT**
- 1902 Webbers Creek, Gresford to
Singleton Road - **EXTANT**

Dare composite timber trusses

- 1905 MacDonald River, Bendemeer - **EXTANT**
- 1906 Williams River, Dungog - **EXTANT**
- 1908 Colemans Bridge, Lismore - **EXTANT**



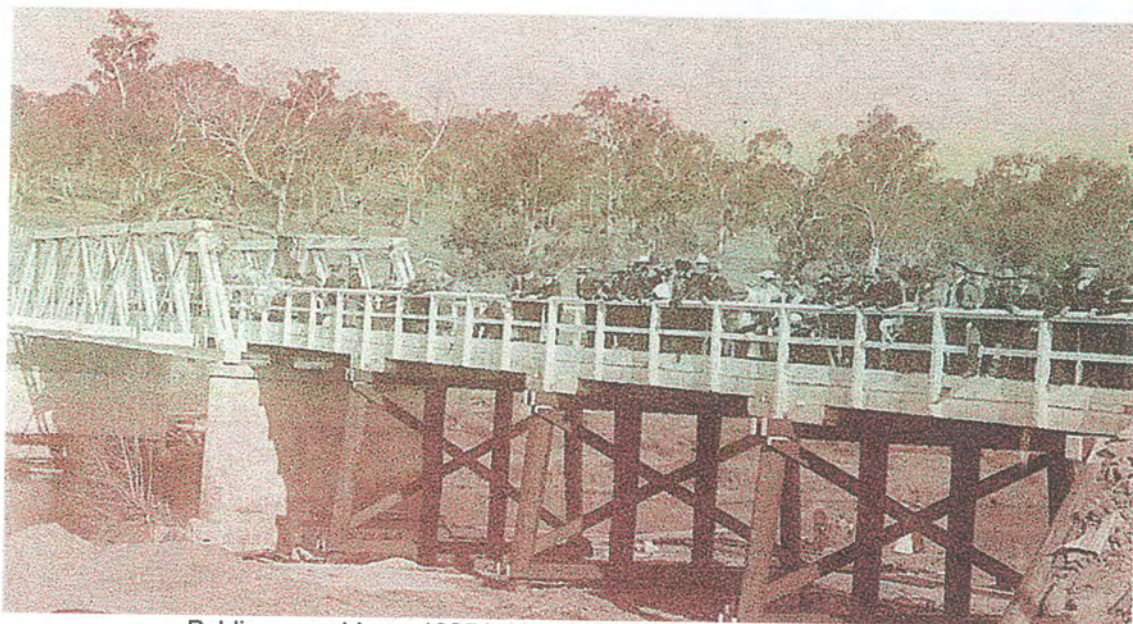
W F Oakes
(Frank Oakes photo)

Steel truss bridge

- 1908 Irving Bridge, Casino

Walter Oakes had a 2-year stint 1903-04 on railway construction in the Cape Colony, South Africa as Assistant and District Engineer but "it was not my line" so he resumed bridge building in NSW.

The 1908 Irving Bridge at Casino may be seen as his crowning achievement, feted at a farewell function, he was made an honorary citizen of the town. He received many work commendations beginning in 1895 with one from the eminent Public Works bridge engineer E M de Burgh. His Bendemeer Bridge is to be honoured as an Historic Engineering Marker by Engineers Australia in April 2005.



Public assembly on 1905 bridge for the opening on 29 September

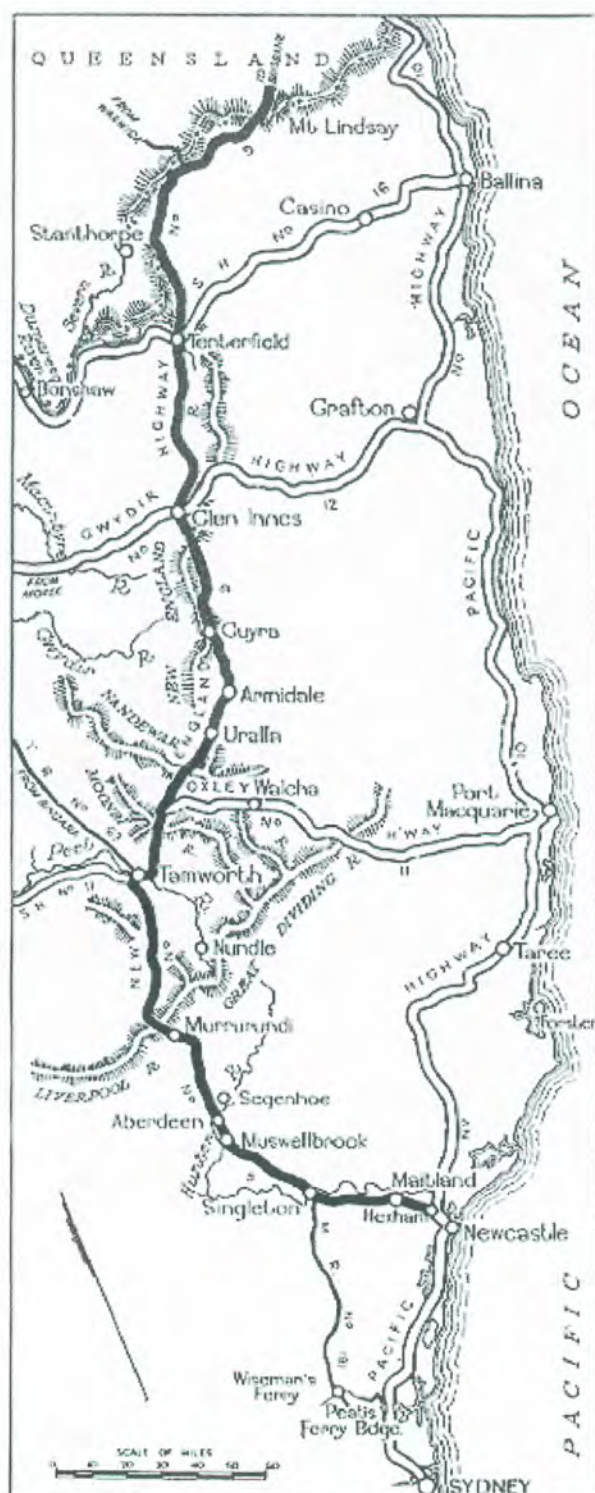


The 1905 bridge in 2004

APPENDICES

GREAT NORTH ROAD – NEW ENGLAND HIGHWAY

Based on MAIN ROADS March 1952 issue, pp 68-76



Introduction

The New England Highway is part of the arterial road system of N S W, being the main inland route running north into Queensland. It leaves the Pacific Highway at Hexham, ten miles from Newcastle, then passes through Maitland, Singleton and all the major towns north to Tenterfield and on to the Queensland border at Mount Lindsay. It is mainly a mountain road keeping to the high ground of the ranges west of the Great Dividing Range.

This Highway originally started from Sydney in 1833 as the Great Northern Road and proceeded via Wiseman's Ferry to Singleton. In 1928 the new route via Peat's Ferry to Hexham was named the Great Northern Road but it was short lived because in 1931 the whole of the Sydney-Brisbane coastal road was named the Pacific Highway leaving the Great Northern Road to start at Hexham.

The dominant feature of the route was the New England tableland, a vast pastoral and agricultural district some 3,000 feet above sea level extending from the Liverpool Range to the Queensland border. It owes its name to some resemblance to England in climate and countryside.

With a long section of the road on the New England tableland the road was renamed the New England Highway in 1933.

He also listed the completion of some 20 large timber bridges, including the 3-span laminated timber arches at Bendemeer (*see later section*).

The extension to Tenterfield began the next year. It proved to be one of the most difficult sections, particularly over the Bolivia Range near Glen Innes.

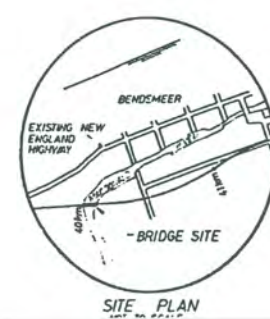
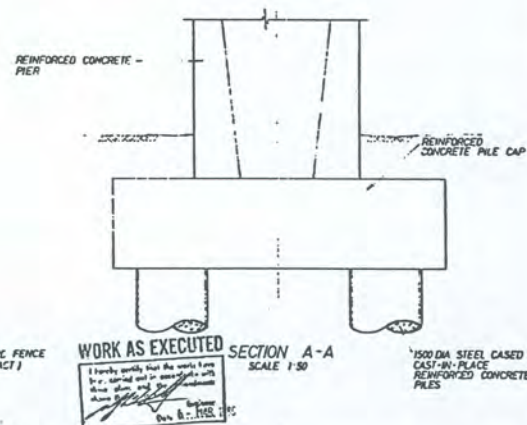
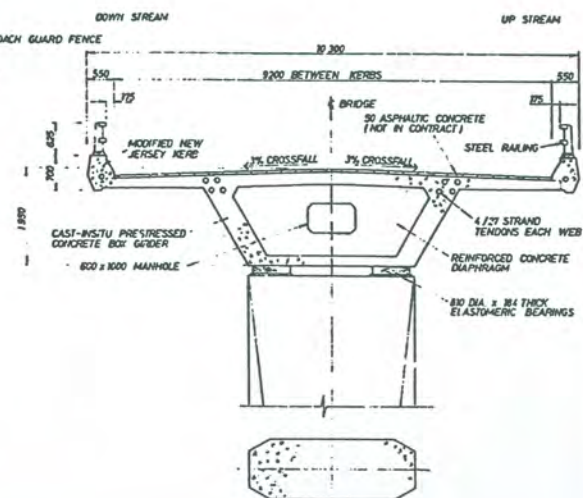
Overall, progress in the improvement of the Great Northern Road was steady and, for the time, considerable. But decline set in with the change of interest by successive Governments to heavily funding railways. This was particularly bad for roads such as the Great Northern Road because the railway was built virtually parallel to it – Singleton 1863, Muswellbrook 1869, Murrurundi 1872, Tamworth 1878, Uralla 1882, Armidale 1883, Glen Innes 1884, Tenterfield 1886 and Wallangarra on the Queensland border in 1888.

The railway was to dominate land transport for the next sixty years until the age of motor transport began to consolidate after World War II. Funding levels reversed and railways declined, with line closures north of Armidale.

There followed fifty years of unprecedented road improvements through to the end of the 20th century, together with hundreds of replacements of inadequate old timber bridges in steel and prestressed concrete, as well as new bridges on regraded and realigned sections of roads.

Bendemeer was a victim of such progress. It had been on the Great Northern Road – New England Highway for around 150 years but has been bypassed due to a highway deviation east of the village in 1985, see attached bridge plan.

However its 1905 “Bendy Bridge” survives and is the centre of centenary celebrations planned for April 2005.



REV	DATE	DESCRIPTION	
DEPARTMENT OF MAIN ROADS N.S.W.			
S.H. N ^o 9 - NEW ENGLAND HIGHWAY			
SHIRE OF PARRY			
BRIDGE OVER MACDONALD RIVER			
GENERAL ARRANGEMENT			
MAUNSELL & PARTNERS PTY. LTD.			
CONSULTING ENGINEERS			
SHEEY	CAMBERRA	GEORGE	ADLAIDE
SCALE AS SHOWN		REGD. No. OF PLANS	DESIGNED BY <i>ONE</i>
DATE MAY 1961		0009-364BC-0006	DRAWN BY <i>ONE</i>
DATE OF ISSUE		DESIGN LOADING MAASRA 1976	CHECKED BY <i>ONE</i>
AL & P. Box 5079/71		SHEET No. 3	PAGE No. 8 / 364 17
			No. OF SHEETS 24

EXAMINED
26 JUL
ASST. BRIDGE ENG. (DESIGN)
DATE 8-2-82

NOTES

- 1 ALL LEVELS ARE GIVEN TO AUSTRALIAN HEIGHT DATUM
- 2 ALL DIMENSIONS ARE IN MILLIMETRES AND ALL REDUCED LEVELS (RL) IN METRES
- 3 MAXIMUM PILE WORKING LOAD 500 TONNES
- 4 SURVEY INFORMATION AND PROFILES TAKEN FROM DMR DRAWING N°0009 364 FC-0005
- 5 E-CEMENT'S EMBANKMENT BEARING

John Brown
BRIDGE ENGINEER (DESIGN)
DATE 2.10.82
John Brown
CHIEF ENGINEER (BRIDGES)
DATE 11.10.82

APPROVED
John Brown
ENGINEER IN CHIEF
DATE 22.10.82



HISTORIC BENDEMEER

Based on notes by Ruth Mathews

The first white man to venture over the Moonby (Moonbi) Range was Edward Gostwyck Cory who in partnership with William Dangar decided to find a way north from Tamworth. So in 1832 with a 12-man party plus his equipment and stock he set off to find new pastures further north. On the first day north he was confronted by what is now called the first Moonbi Range, arriving just before nightfall.

The task of climbing this "wall" was so steep (as is the case even today) and downright dangerous that he set up camp in the gully below the point of his actual ascent. He then cleared a track to get his stock and pack horses over the first range and continued his climb up over the second Moonbi finally arriving at a river site that is now Bendemeer. He must have met local Aborigines because he named the river the Muluerindie, which means "cool running water" in their language. Cory then continued north to where he finally settled near the present "Goswyck Station".

The next settler in the Bendemeer district was Richard Wiseman who arrived in 1834 and settled on land near the river. He employed a manager named Henry MacDonald to care for his property and over time people passing though started to call the river MacDonald's River such that the former name Muluerindie was partly forgotten. However, the plans for the 1905 bridge (*see following sections*) are titled for the Muluerindie River and the name has been revived for the new low level concrete bridge, completed in the late 1990's and named "Muluerindie Bridge". But the river is still the MacDonald, the (s) having long been deleted.

The initial settlement of Bendemeer was known as "MacDonald's River" until 1856. Richard Wiseman held the 'MacDonald's River Run' until 1836 when he moved away and another settler took over the run until 1839.

Onto the scene came Thomas Augustus Perry J.P. He took out pasturing rights for the 'MacDonald's River Run'. However, he did not live at there until 1856 but once settled, he renamed the property "Bendemeer Station". He became a very important figure in the area having control of the whole valley, 6,500 hectares and in 1856 he also renamed the settlement Bendemeer.

He held the position of Honorary Magistrate from 1859-1864 when his son Frederick was officially appointed. He was the leader of the committee that pushed for the first bridge over the MacDonald River and given the honour of opening it in 1865.

He died in 1872 aged 54 and was buried in the gardens of "Bendemeer Station". Streets in Bendemeer are named after some of Perry's children, Caroline, Frederick, Henry, Fanny to name a few.

The first bridge over the MacDonald River consolidated the route to the north. No longer were travellers and stock marooned in Bendemeer in flood times even though there was a fair sized area of land nearby for holding stock. Therefore more and more settlers came and travelled northwards to open land. Bendemeer became a very important overnight resting place for travellers and very quickly wine shanties sprang up along the Great Northern Road approximately five to seven miles apart, as this was generally the distance a bullock team travelled in a day. In most cases they not only supplied strong refreshments but also accommodation for the weary travellers. In Bendemeer itself it was noted that there were five hotels or inns in business in the 1860's.

The first store opened in Bendemeer was in 1847 and in 1855 another store opened on the corner of Caroline and Fanny Street, and the Post Office was conducted from there. But in 1872 a general store was built in Caroline Street. It will close at the end of September 2004 and become a residence.

Floods have always been part and parcel of the MacDonald River. It is a cold river, very beautiful in parts and known for its trout fishing. It is also a dangerous river in flood time due to its treacherous swift flowing waters. The first major flood was in 1864 when flood waters flowed through the newly constructed stone home of "Haning", and this flood also was recorded as having flooded Bendemeer village. In 1893 the flood waters were reported as having reached the decking of the first Bendemeer bridge. Another major flood was recorded in 1910.

However the biggest flood ever recorded was on Friday 13th (please note) in 1962 after 860 points (215 mm) of rain fell over a period of twelve days. The river was already a "banker" when heavy storms fell in the headwaters of Rose Gully, Poison Swamp and Dunduckety Creek as well as Elbra's Gully causing major flooding throughout the township. All businesses and twenty five homes had to be evacuated. The water reached a height of 18 inches inside the hotel, and the main approaches of the bridge were swept away closing the New England Highway for three days. This flood reached the guttering of the "Haning" home.

Over the years the village of Bendemeer has served a "niche" role for the local community and the agricultural/pastoral district. However, its proximity to Tamworth and the increasing flow of through road traffic inhibited growth. There is an element of isolation now that the 1985 New England Highway deviation passes east of the village.

However, it has a place in the history and heritage of road infrastructure, being the site of the first of the composite steel and timber Dare truss bridge which superseded the last of the laminated timber arch bridges.

Historic buildings in Bendemeer



The 1860s 'Haning' stone hut



The 1864 Presbyterian Church



The 1864 Bendemeer Hotel



Photographs, courtesy
Jeff Day

THE 1st BENDEMEER BRIDGE

In the early 1850s bridge building was the responsibility of the Colonial Architect (1849-54) Edmund Blacket who, in order to extend the span of bridges beyond the 30-40 feet limit of timber beam bridges, chose the laminated timber arch. It was British technology which could take spans to around 100 feet.



Typical timber beam bridge



1852 laminated timber arch bridge, Wallis Creek, Maitland

Eight laminated timber arch bridges were built in New South Wales between 1852 and 1865, the last three after the Department of Public Works (established in 1856) took charge of bridge design and construction. Their use of large amounts of the abundant local hardwoods conformed with the government edict that as much local material as possible be used in all infrastructure.

Although these bridges were hailed as the marvels of their time, their overall durability did not match expectations. The thin planks were curved by a steam process and cross-bolted to form the laminated arch. Unfortunately, suitable glues for securing and sealing the interfaces of the laminates were unknown and cross-bolting could not maintain water-tightness between plies (as in modern timber laminated/plywood constructions). Consequently, moisture penetrated the inner laminates causing rot, hence structural weakness. It was impossible to treat the inner laminates so reconstruction was the only method of replacing the rotting laminates.



Typical separation of laminates due to rot

Within 30 years a programme began of complete replacement of all these bridges, usually with timber trusses. The laminated timber arch construction was not a long-term cost-effective design. The 1865 Bendemeer Bridge was the last one built.



Bendemeer laminated timber arch bridge during construction in 1864 and after completion c1900

Tenders had been called in the Government Gazette as early as 6 April 1859 and that from W E Chowne was accepted on 15 June 1860. However, by 10 August 1863 fresh tenders were called and Jean Frey became the second contractor on 22 September 1863. His acceptance note appears at the top right hand corner of the attached plan, Commissioner William C Bennett's signature dated 22 September 1863 appears just right and below the title.

For whatever reasons, Jean Fey was relieved of the contract and David Baillie continued construction through to completion under an "amended agreement" with the Roads and Bridges Branch. His acceptance on 5 February 1864 is on the attached plan, left of the title.

The *Armidale Express – Supplement* 22 April 1865 recorded completion and the opening ceremony took place on 8 May 1865, see attachments.

Despite being a beautiful timber bridge in its mountain stream setting, see attachment, it was not strong enough for heavily loaded wagons, it suffered flood damage and developed the problem of rotting laminates. By 1895 it was condemned and closed forcing traffic back onto the earlier causeway crossing. Fresh moves were put in hand for a new bridge, the extant 1905 Dare timber truss bridge, see cover photograph.

aid the Directors believed had done quite right in certificate to Mr. Shannon to the Directors. The that was to be done with wner had been punished law. The sheep were in Directors had no power of it. In fact, Mr. Shan- with the sheep in spite without having a certi- cause him much greater ties a better opportunity without risk to them- certificate of the sheep on the 6th April, Mr. all upon such parties to rounds for stopping him. the sheep came from, knew of its reputation, p. having been twice in- b and pronounced clean, ances into consideration, ght that the sooner they eep the better.

murring to give the certi- wishing its issue to be nesday next, apparently ly to the Chief Inspector

who had already stopped on continuing some re- him that he must obey ructions, and that in this ctors had nothing to do nspector. The Inspector f the Directors, and if he their instructions they t to do. The Chairman ast of a certificate to be by the Inspector with-

D FLOUR COMPANY.

noon a public meeting of n the above company was n Tysoe's hotel. About On the motion of Mr. A. led by Mr. John M'Leu- alay took the chair.

y pertinent observations n with regard to the elec- rs, of whom five were to

ker said that as Mr. Simp- r for the Company, was nt, he might state that the nt had been signed by 25 that 239 shares had been e were promises of many ed for. He intended to shares in addition to the

drawn, at the request of the applicant.
Walcha, 11th April, 1865.

BENDEMEER.

(From a Correspondent.)

THE Bendemeer Bridge is now an established fact. On Wednesday last, the 5th instant, it was completed, and the workmen were regaled with ale, brandy, &c., on the centre of the Bridge. The healths of Mr. Bennett, the engineer, and Mr. David Baillie, the contractor for the Bridge, were drunk with three times three. Both gentlemen were absent. Then the health of Mr. Superintendent Bayley was drunk, and responded to by that gentleman. Then followed that of Mr. Elder, Mr. Baillie's manager. The structure was then named the "Bendemeer Bridge," but there being no ladies present I think it premature.

The same afternoon Mr. Dixon the store-keeper and Mr. Elder rode over the Bridge. They being the first to ride over, of course they had to pay their footing, which was done at the Royal Oak (Mr. Williams's), the men being all taken there.

On the following day, the approaches being sufficiently forward, Mrs. Glover, the hostess of the Macdonald Inn, and Mrs. Elder were driven across in a spring cart, by Mr. R. Hetherington, followed by the drays of Mr. Dorrington, the contractor for the approaches, containing all the workmen, who gave three hearty cheers on crossing.

Owing to the approaches not being finished, the Bridge will not be opened for a few days I believe. It is now under lock and key, much to the annoyance, it is said, of a select few who would like to say they crossed first. Knowing nothing about such work, my opinion goes for little, but I may say it appears to be a firm piece of work and reflects great credit on the engineer, contractor, and all others who have had to do with it. The only pity is that the approach on the Northern side should be carried along the flat, which causes a very abrupt turn. In fact, our local teamsters say it is impossible to drive a team on to the Bridge. It is to be hoped that Mr. Bennett will see the importance of remedying this. There is no doubt that the deputation appointed to wait upon him will do their utmost to get it altered.

BUNDARRA.

(From our Correspondent.)

A SAD accident occurred here last Friday evening. Some children being at play, one of them, five years of age, a son of Constable Childs, was kicked by a horse, receiving the blow full in the face. In all probability the child was very close to the animal, and as little form was driven like a feather from the

mere fruitless argumentation, and w to go on to something practical. 2d would have considered himself guilt sin of schism if he had kept back His refusal to go into union mi thrown an obstacle in the way of the usefulness for years to come. 4th by our standing aloof, and fixing too much on our denominational pec we were in danger of losing sigh grand object which ought to engagtention of a Church of Christ, viz, th ing of the Gospel, in order that los might be saved. 5thly. That the C a whole would gain largely by an a its numbers in usefulness and respe and the tendency to petty personaliti was apt to arise in all small bodies checked. The Chairman then remai the gentlemen present had now an nity to give expression to their view deeply interesting question. In th man's statement of facts several poi very apparent. 1stly. The ministr not be accused of precipitancy in thi as some had asserted. 2ndly. Neit they be blamed as wanting in respec opinion of brethren in this matter, opposing views, else it might have, tled long ago. 3rdly. That the cau ruption in the Colonial Church in the refusal to erase certain words name of the Church, viz—the w connection with the Established C Scotland. 4thly. That when the union was introduced, the Free C along said that the necessary con- quired in order to their uniting other body was their declaring t "Were not in connection with th lished Church of Scotland." 5 honest men, therefore, when the ct complied with our condition we we to fulfil our promise.

Mr. W. W. Fraser in a brief spee a resolution to the following effect— congregation, having heard of the pr union that had been formed bet Synod of Eastern Australia (Free and the Synod of New South Wale to adhere to the "United Chur would also express their desire general union of all the Pre Churches in the colony may soon pleted.

The motion was seconded by Fletcher.

Thereafter Mr. D. K. M'Intyre, moved in opposition somewhat as That in the mean time we proceed in the matter of union, but wait ti more light; and Mr. R. Galloway

BENDEMEER BRIDGE:

8th May, 1865. THE GRAND OPENING.

"Yesterday about 200 persons assembled to witness the opening and naming of our bridge. The ceremony was performed in the usual manner by breaking a bottle of wine over it. Mr. Perry addressed the assemblage as follows:- Ladies and gentlemen the pleasant duty of opening and naming this bridge has been entrusted upon me, but before performing the ceremony I desire to address a few words to you. It will be in the recollection of many of you that when I came to reside here a little over eight years ago, Bendemeer was only known as my station, and the crossing place at the river was looked upon as the most dangerous on the main northern line of road. This was speedily brought to my notice, and as magistrate, by having to hold inquiries on bodies having been drowned in attempting to cross the river during floods. I at once saw that a bridge was urgently required, and headed a petition to the Minister of Public Works asking for this boon to the district and Bendemeer in particular. I say to Bendemeer in particular, because you must recollect the injury done to the pasture in the neighbourhood by the numbers of teams and thousands of head of cattle and sheep who were frequently detained for up to a month at a time on either side of the river. You will say I was activated by interested motives in trying to enable these stock to be moved off my run as soon as possible. I do not deny it, no doubt I was, but this interest was a benefit to you and the community in general I firmly believe that but for interested motives there would not be so much done in the world as there is. I am quite certain that there would not be so much done at Bendemeer, therefore you should be thankful that my interestedness has done both you and I good. We have however, owing to the procrastination of governments the failure of contractors and other causes, been obliged to wait many years before we have been able to cross with safety this beautiful and dangerous river. I trust the splendid bond which now unites the banks of the river may prove one which will unite the inhabitants of either side in brotherly fellowship and the facility it will give the northerners to approach the public establishments on the southern side of the river, will do away with any little jealousies which may have been felt. The bridge reflects the greatest credit on the engineer Mr. Bennett as well as on the contractor Mr. Baillee and his men who have so faithfully performed their work. I said before that on me devolved the honour of opening and naming this bridge. I named my station Bendemeer and a few years ago I had the honour of naming this town Bendemeer and now I name this bridge the Bendemeer Bridge and declare it open to public traffic" Upon which there was loud cheering. Mr Perry then added, he was glad to see the children of the National school present.

The river would no longer be an excuse for their absenting themselves from the school but they must take care until the footbridge was completed, not to cross the bridge when teams or cattle were upon it. He congratulated the public on their excellent approach which had been made to the bridge on the north side of the river at the suggestion to the deputation which had recently been appointed to wait upon the commissioner. Mr. & Mrs. Perry and part of their family then drove across the bridge and back. Then they proceeded to the Court House and distributed blankets to 40 aborigines who were present and who loyally cheered.



VIEW OF BENDEMEER, N.S.W. — SEE PAGE 3.

ILLUSTRATED
SYDNEY
NEWS

6 July 1870
page 5

*Note the laminated timber arch spans,
pre-dating generally quoted 1874 bridge.
Constr seems to have completed April 1865.*

Evolution of the timber truss bridge in NSW

by Don Fraser, Engineering Heritage Committee, Engineers Australia, Sydney.

The truss, unlike the suspension cable/vine, the rock arch, the beam/log and the dome/cavern, has no equivalent in nature. It is a creation by man, first formalised by the sixteenth century Italian architect Andrea Palladio (1508-1580), figure A.

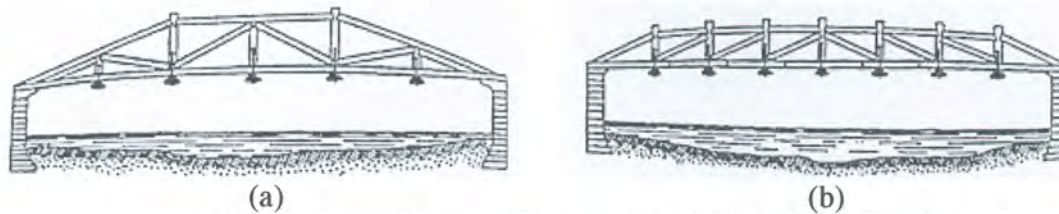


Figure A Palladio's drawings of timber truss bridges c1550.

The truss is a spatial assembly of relatively short members to form a much larger structure that has a high load capacity/weight ratio. It is particularly efficient for spans exceeding 30 metres (100 feet) and up to 610 metres (2,000 feet). Most of the great bridges of the world are steel trusses.

In New South Wales, after the establishment of the Department of Public Works (PWD) in 1858, a standard timber truss bridge design was developed for road bridges by Chief Engineer and Commissioner for Roads, William C Bennett. It was a relatively low cost bridge, being constructed from local hardwood timbers, such as ironbark, rather than the expensive imported iron. Bennett's design, modelled on the Palladio truss in figure A(a), has become known as the "Old PWD Truss", figure B(a), and it allowed a rapid expansion of the burgeoning road network from 1870 to 1884. Only two Old PWD truss bridges remain in New South Wales, both classified as of State heritage significance.



(a) Old PWD truss



(b) A McDonald truss

Figure B The modified Palladio trusses 1870 to 1894.

The OLD PWD truss was the first in a five stage evolution of the timber truss road bridge in New South Wales, their names were OLD PWD, McDonald, Allan, de Burgh and Dare. The four following the OLD PWD truss have been named after their designers, all eminent engineers of the NSW Department of Public Works (PWD).

However, the old design had some structural faults and was expensive to maintain. In 1884 John A McDonald, the PWD Engineer for Bridges, produced an improved standard design to rectify the worst of these problems and to cater for increased loadings. His design has become known as the McDonald Timber Truss, figure B(b), and five such bridges survive, all of State Heritage significance. He also pioneered the new technology of composite construction whereby a mix of timber and steel members was used to their best structural advantage. The 1893 bridge over the Lachlan River at Cowra had three large composite truss spans. After its replacement in 1986, a sample truss was mounted in the riverside park but had to be demolished for safety reasons in 1995.

In the early 1890s Assistant Bridge Engineer, Percy Allan, began a comprehensive redesign of the timber truss bridge using data on the strengths of Australian timbers from Prof Warren's testing program at Sydney University and the experiences in constructing and maintaining the previous designs. He chose the American Howe truss, an arrangement anticipated by Palladio 400 years earlier, figure A(b). In his cost-effective design, now known as the "Allan Truss", he used marketable lengths of timber, minimised the adverse effects of water holding in joints, countered the effects of the high shrinkage of Australian hardwoods and devised ways of replacing defective members without taking the bridge out of service. His new design came into service in 1894 with the ability to carry 50% more load than its predecessors but with 20% less material. Approximately 35 Allan truss bridges survive, figure C, with 11 of State Heritage significance.



Figure C The clean simple lines of an Allan truss, easy to construct and repair.



Figure D A general view of a deBurgh composite truss and a closer view of a pinned joint with new replacement timbers.

Another member of this famous team of PWD bridge engineers, which included Harvey Dare and J J C Bradfield, was E M deBurgh. Following the concept of composite construction, pioneered by J A McDonald (1893 above), de Burgh developed it into a viable standard design in 1899. He used the American Pratt truss with timber for the top chord and the vertical members, iron rods for the diagonals and a bottom chord member made from structural steel sections plus the American practice of using single steel pins at each of the bottom chord joints, figure D.

The first two deBurgh composite bridges at Queanbeyan and Inverell in 1899 (both replaced) had sloping end members as in the Howe/Allan trusses. This was an unnecessary detail for the Pratt arrangement of members and so vertical ends were adopted for all subsequent de Burgh truss bridges.

This new design, which now bears his name, promised great economies in maintenance, figure D. However the inclusion of pinned joints, an American practice, had become a hindrance to certain aspects of maintenance and future strengthening. Consequently, the design was used in NSW only for a short period 1900 to 1905 during which time twenty such bridges were built. Twelve survive with five being of State Heritage significance.

Despite the drawbacks of the de Burgh design, the advantages of composite construction were clearly recognised and Harvey Dare reworked the Howe/Allan truss into a composite structure with conventional riveted joints. It was the last of the five stages in the evolution of timber truss bridges in New South Wales. By 1935, with in excess of 400 timber truss bridges having been built, they became a characteristic feature of the New South Wales road network, so much so that it was referred to as “the timber bridge State”.

But during the 1920s, the increasing availability of locally produced steel allowed a gradual changeover to steel truss construction.



Figure E A typical composite Dare truss of the Howe type with timber diagonals and steel bottom chord.

THE 2nd BENDEMEER BRIDGE

The famous Percy Allan wrote a series of articles on Highway Bridges in 1924 for the *Industrial Australian and Mining Standard*. In the September 4 issue on page 357 he wrote the following about his eminent understudy Harvey Dare,

Mr. Dare, M.Inst.C.E., in 1903, when in charge of highway bridge design, adopted a composite truss of the Howe type for spans of 104ft., in which the verticals and bottom chord are of steel with timber diagonals and top chord. Several bridges of this type have been erected within the State, amongst these being that shown in the following photograph over the Macdonald River at Bendemeer, built in 1905 at a cost of £5500.

This composite steel and timber truss is now known as a Dare truss.

Some years ago, the author of this Nomination Report had access to one of Harvey Dare's calculation books held by the Department of Main Roads, Bridge Branch. The particular book for 1898-1909 contained Harvey Dare's original calculations for a 91ft (27metre).

The Bendemeer Bridge with a span of 103' 7½" was the first Dare truss highway bridge built in New South Wales, so its survival and centenary are particularly significant.

The call for tenders appeared in the Government Gazette on 27 October 1902, p7549 and a tender from Littleproud & Taylor, Westmead, was accepted on 27 June 1904, p5102. Whatever the cause, a fresh contract was let to W F Oakes on 17 October 1904, p7834. A contract for supply of the fabricated steelwork was let to the Government Dockyard, Newcastle on 24 October 1904, p8068. W F Oakes carried the work through to completion. Mechanical engineers Poole and Steele were also involved in the project.

A set of drawings from the Roads and Traffic Authority's Archives is attached. They were signed by W J Hanna, Commissioner and Principal Engineer on 11.4.1904 along with H H Dare, Assistant Engineer.

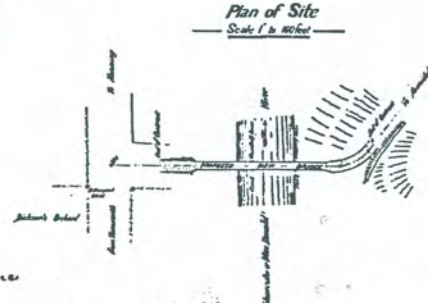
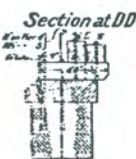
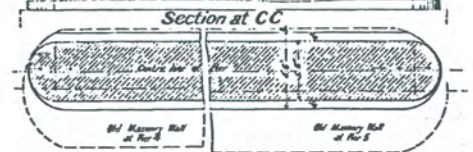
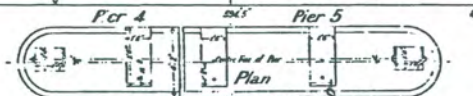
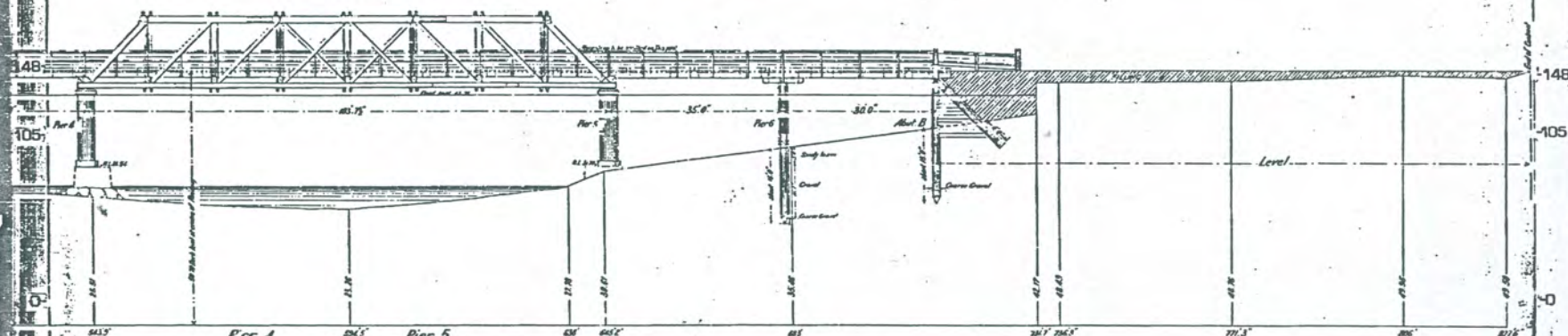
The bridge was opened on 29 September 1905, opening speech attached. It was a remarkable construction achievement by W F Oakes in 11 months. It may be that Littleproud & Taylor had done the piling and other foundation work during their 4 months on the job, leaving the superstructure and timber beam approach spans to Oakes.

The bridge was in service without major repairs until bypassed in 1985 by the eastern deviation of the New England Highway and is still regularly used as a footbridge when the MacDonald River covers the low-level concrete bridge.

**BRIDGE OVER MULVERINDIE RIVER
AT BENDEMEER
on Main Northern Road**

General Elevation
Scale 1/4" = 10'

W. R. L. Jones
Civil Engineer
11-11-1914



FRAME 1 OF 2

SHEET 1 OF 3

0009 0908C0118

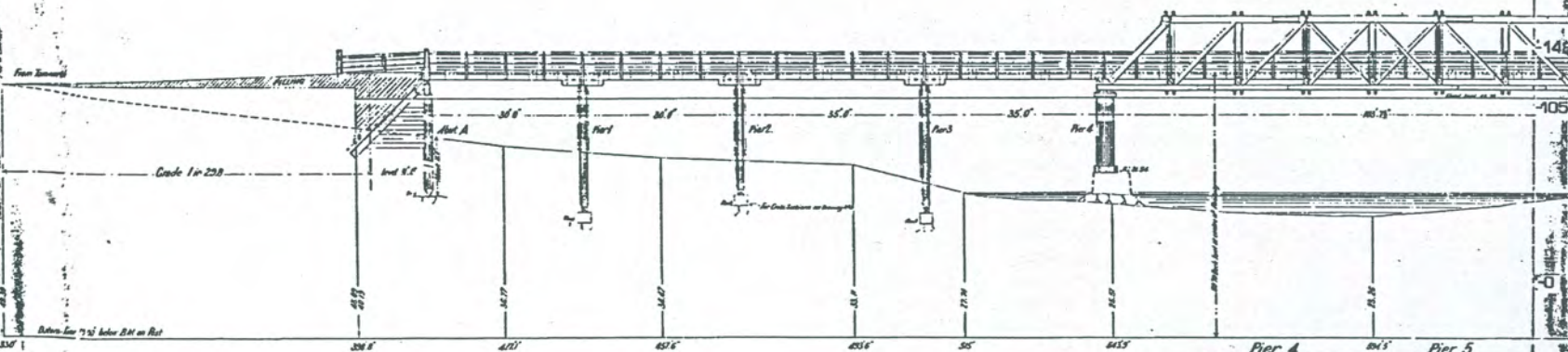
W. R. L. Jones
Civil Engineer

N^o 1

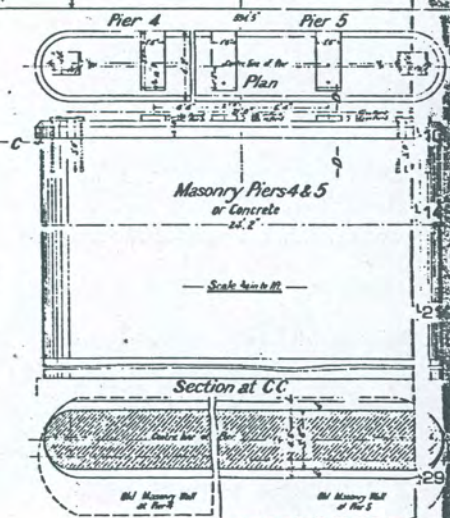
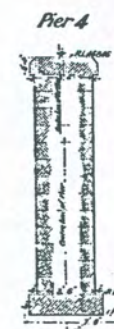
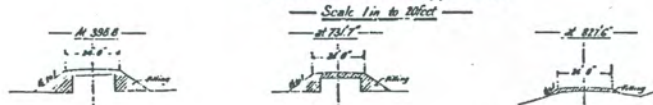
DEPARTMENT OF PUBLIC WORKS
17 JACO ALZ BRIDGES BRANCH

BRIDGE OVER MULGERINDIE RIVER
AT BENDEMEER
on Main Northern Road

General Elevation
Scale 1/4" to 1'



Cross Sections of Approaches



000R 0908C0118
SHEET 1 OF 3
FRAME 2 OF 2

OVER MULUERINDIE RIVER AT BENDEMEER

ARRANGEMENT AND DETAILS OF TRUSS SPAN

Handwritten signature
11-11-11

INVERTED PLAN OF TOP CHORD

ELEVATION

SECTION N-N

SECTION O-O

PLAN OF BOTTOM CHORD

SIDE BRACES

SCUPPER

CL SHOES FOR BRACES

W & L WASHER PLATES

SUSPENSION RODS

WIRE BRACING RIB

CL SHOES FOR BRACES

BATTERY BRACE CONNECTIONS

WRAPPER PLATE

PLATES FOR CROSS GIRDERS

SCALES
1/4" = 1' - 0"
1" = 1' - 0"

DETAILS OF BOTTOM CHORD

SECTION - Y-Y

BEARING PLATES

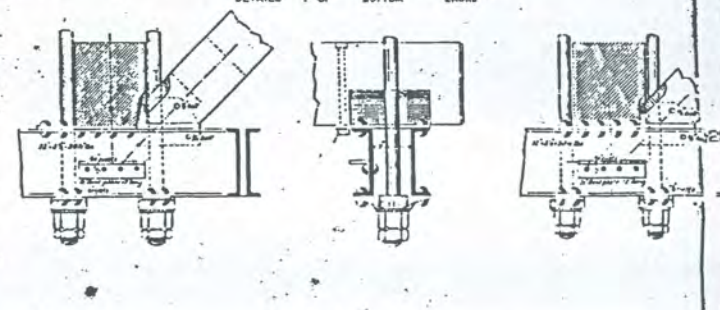
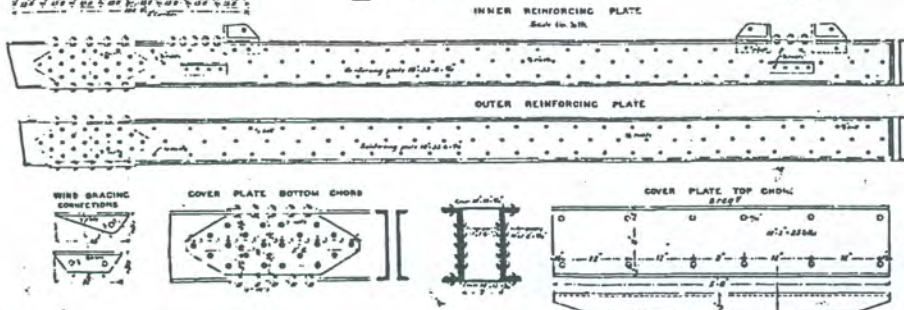
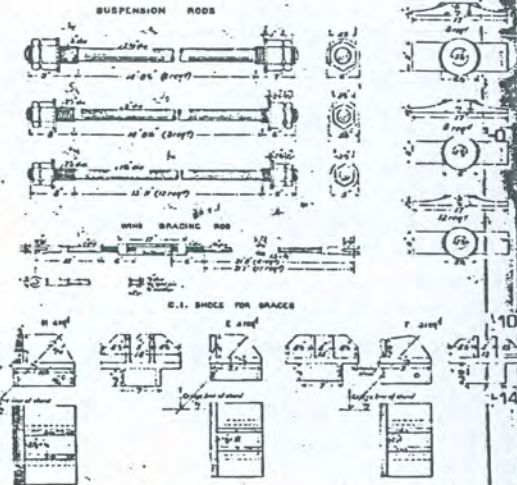
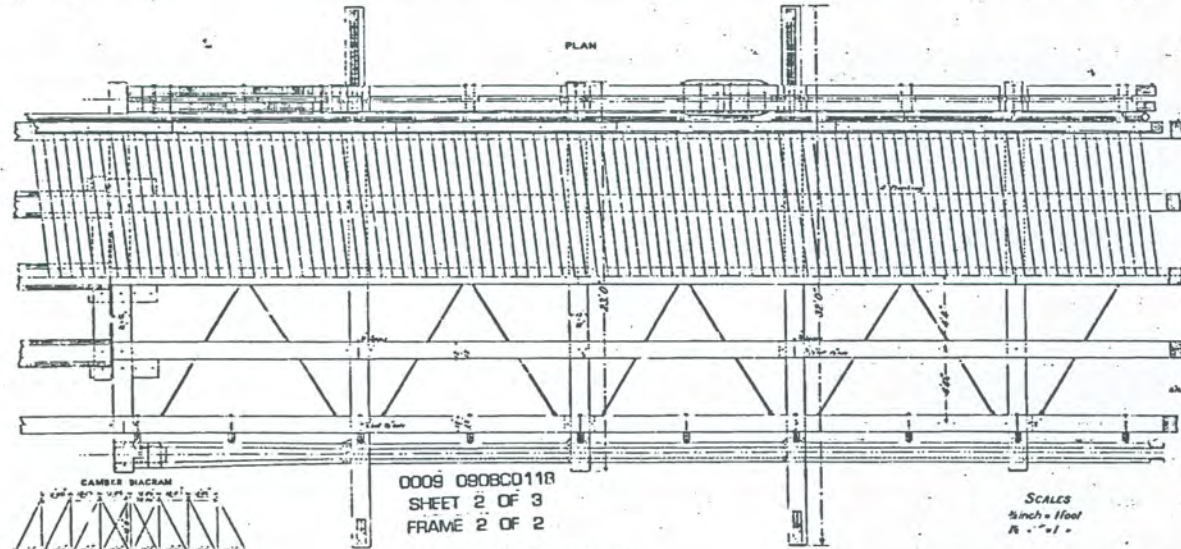
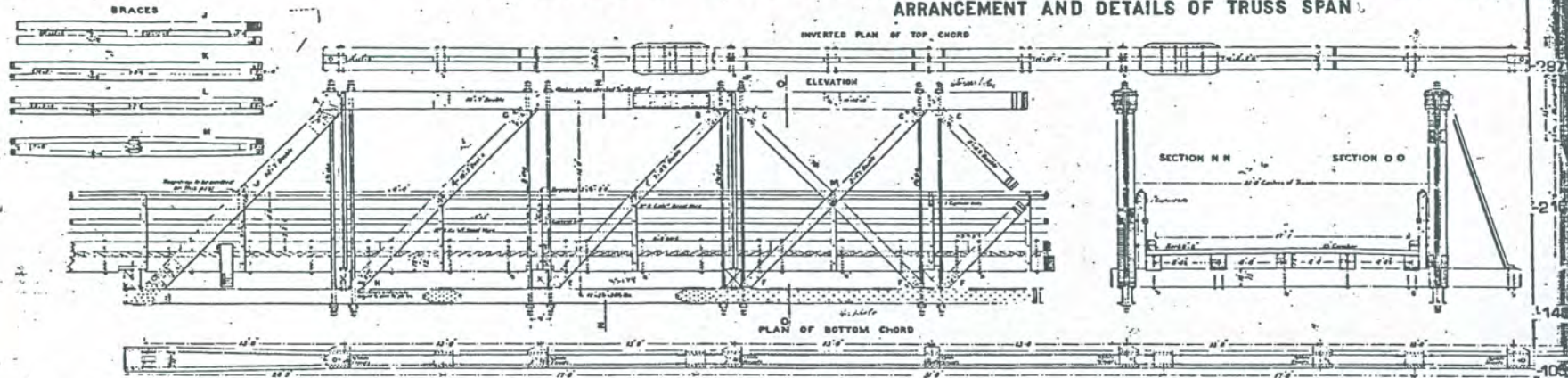
28118

N^o 2

DEPARTMENT OF PUBLIC WORKS
ROADS AND BRIDGES BRANCH

BRIDGE OVER MULUERINDIE RIVER AT BEN

ARRANGEMENT AND DETAILS OF TRUSS SPAN



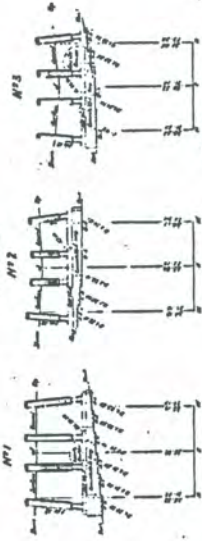
SCALES
1 inch = 1 foot
1/8" = 1"

BRIDGE OVER MULVERINDIE RIVER **AT BENDEMEER** on Main Northern Road

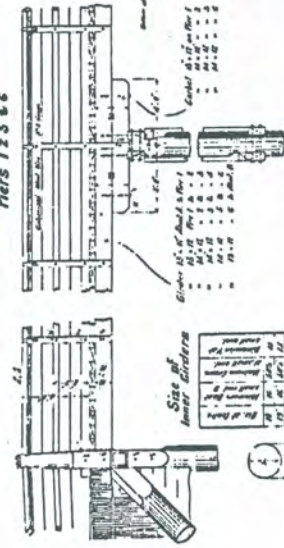
Nº 3

DETAILS OF APPROACH SPANS

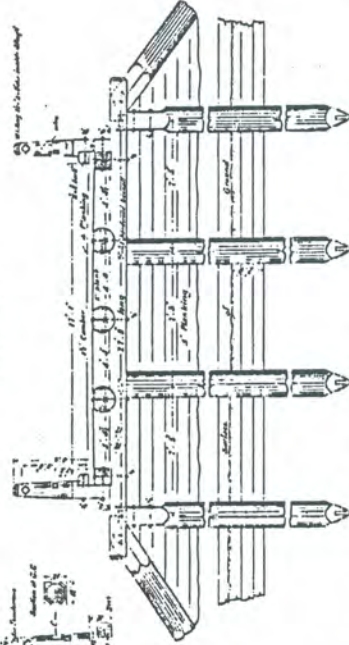
Piles of Piers



Elevation
Piers 1, 2, 3 & 6



Abutments



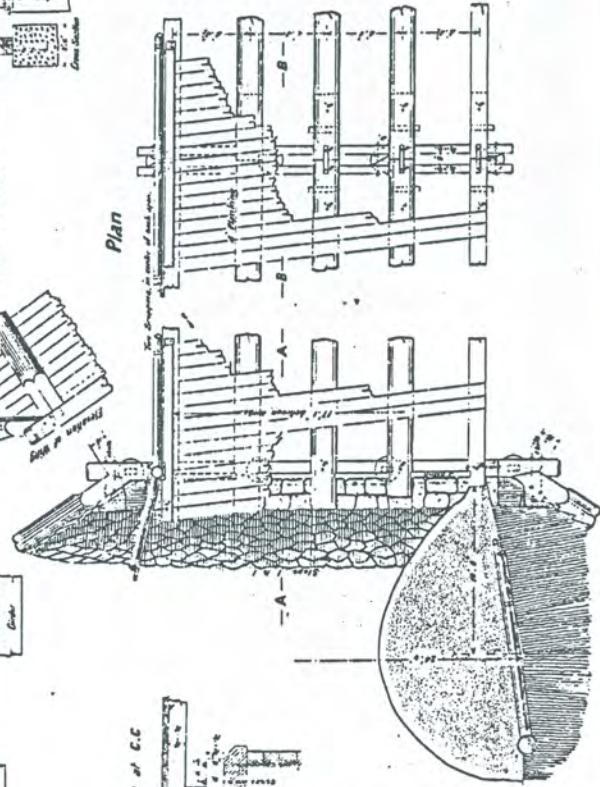
Section at A.A.



Section at B.B.



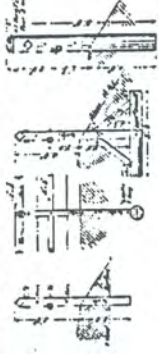
Plan



Section at C.C.



HANDRAIL ON EMBANKMENT



Wedge key



Strap



SCALES



The second Bendemeer Bridge was opened on 29 September 1905 by the Hon. S W Moore, Minister for Mines and Agriculture.

The following extract from his speech appeared in *The Tamworth Observer* on Saturday 7 October 1905.

"Mr. Moore said on rising they might look back to the time when they had difficulty in travelling through want of railways and bridges. Some 40 years ago, when the old bridge was built, there was a total of 100 miles of railway; but now there was a total of about 3,500 miles of railway in the State. The total length of bridges in the State was 60 (?) miles. This immense length of bridges did not give any direct returns to the development of the country, but the roads and bridges helped to form value to the State to the extent of about 2,000,000 pounds. The Chairman (the last speaker) said that the old bridge lasted about 40 years, and those present hoped that this new bridge would last 100 years or longer. No doubt in the 40 years that had passed improvements had been made and children in that time been born also made great improvements and those present wished them greater success than they themselves had achieved, also in the children that were to come, as these young people growing up were the hope of the future. It was not in the school days that they looked back upon their lives, it was in after days. He likened the school days as a bridge. As they looked back on their school days so they would on the opening of the bridge. As a member of the Government he had great pleasure in being present on that day and wished their bridge a long life. In conclusion, he wished them and their district every success and said he was glad to be accompanied by a man who was not the same as himself in Parliament, but in opposition, which showed that they were of good friendship out of business. (Applause).

Mr Holman M.L.A. said he felt it a great pleasure to be present at the opening of the bridge that afternoon, although he and the previous speaker differed in politics. The speaker then went on to say that one of the most important links in the Great Northern Road was a bridge over a river of this kind, the structure of which cost 3,000 pounds to span this important river in order to assist traffic on the Northern Road for a number of people for a great many years to come, and he hoped it would be prosperous for the district and people alike.